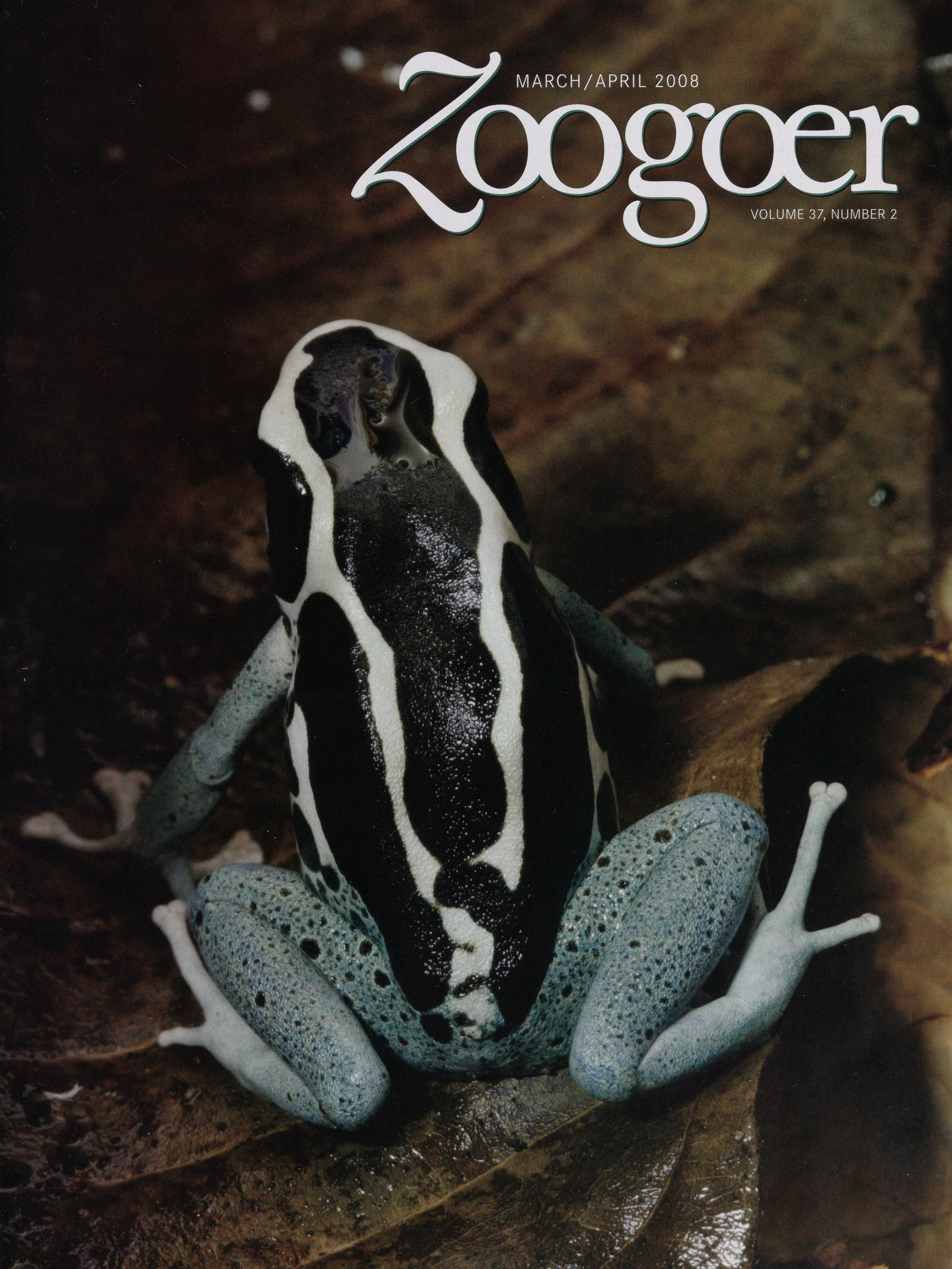
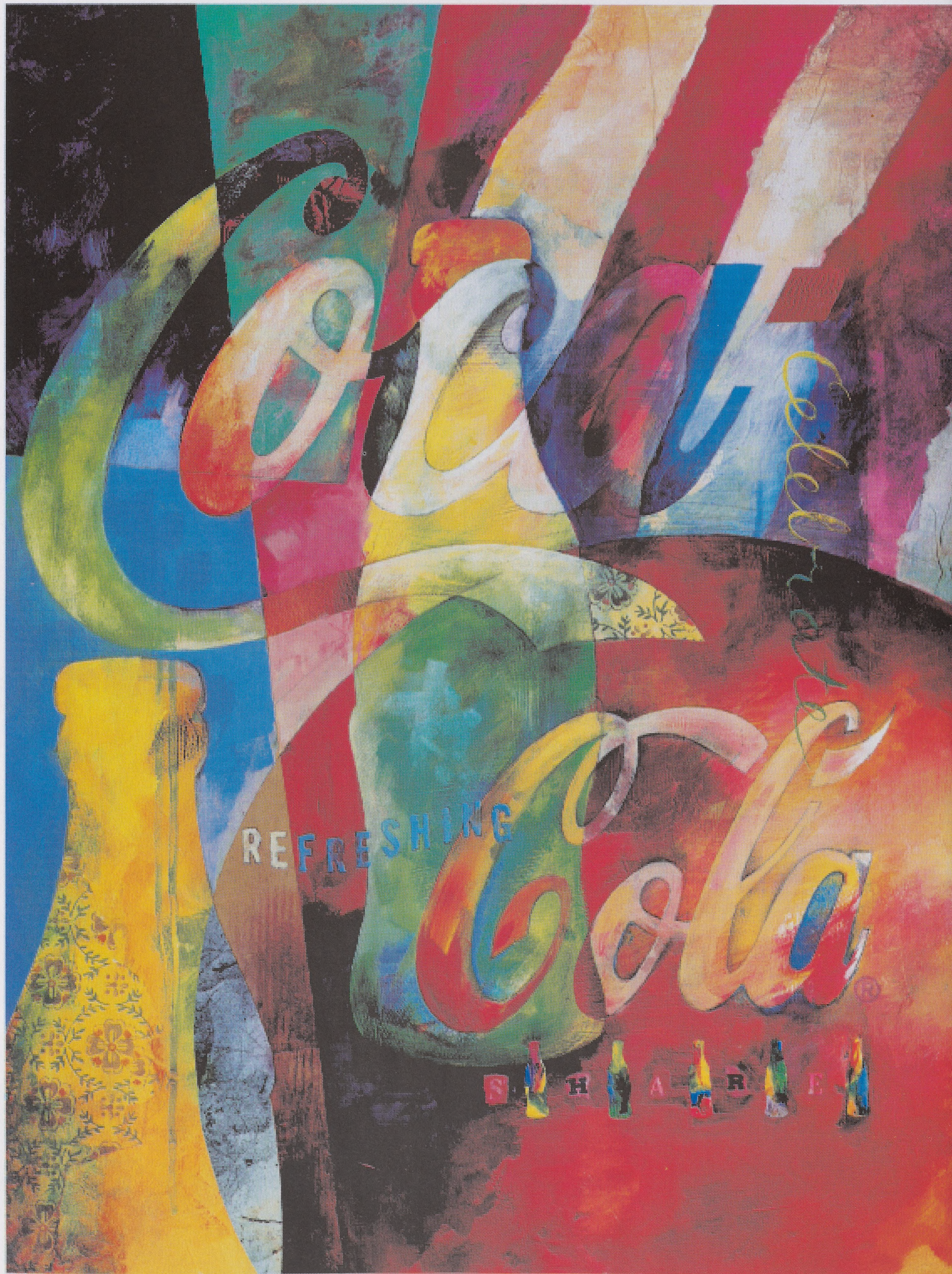


Zoogoe

MARCH/APRIL 2008

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Zoogoer

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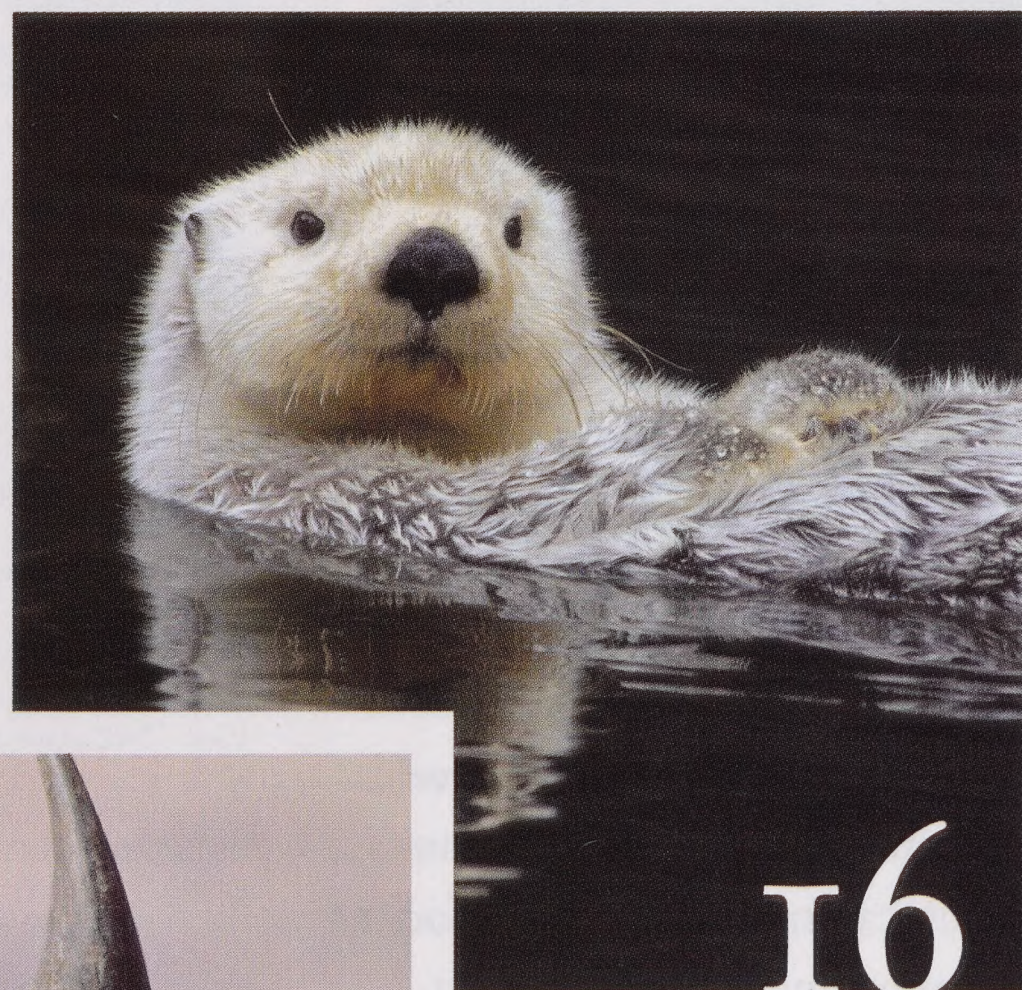
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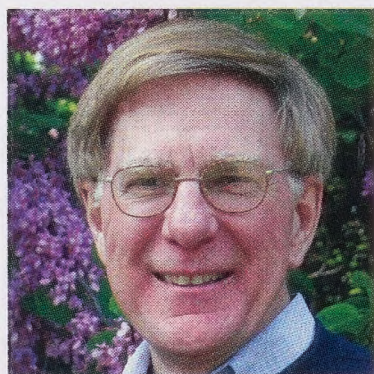
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FONZ Hits Half Century Mark



Never underestimate the ability of a small group of committed individuals to change the world. Indeed, they are the only ones who ever have.

—Margaret Mead

In 1958, *The Washington Star* reported, “The truth is that the National Zoo is falling apart at the seams.” This dire assessment was precipitated by the death of a girl who leaned into a lion’s cage and was snatched by the big cat. But even before this tragedy, the Zoo’s decrepit state concerned its neighbors. In fact, about two months earlier, on April 10, a small group of people from the Connecticut Avenue Citizens’ Association met to determine how they could help the Zoo emerge from the “financial and administrative morass that was strangling [it].” This meeting marked the founding of Friends of the National Zoo—and the onset of the National Zoo’s renaissance.

The fledgling group quickly set about to remedy the Zoo’s most pressing problem: insufficient funding, due in large part to its peculiar administration. The Smithsonian Institution administered the Zoo, but its funding came from the District of Columbia’s federal appropriation. Not surprisingly, given the District’s other needs, funding a “national” zoo was among its lowest priorities. While working to bring the Zoo entirely under the Smithsonian, which happened in 1970, the group early on persuaded federal officials to fund the Zoo adequately and, in 1963, to provide nearly a million dollars to implement a ten-year master plan for capital improvements.

While helping to increase the Zoo’s financial strength was a top priority, FONZ soon expanded its mission to include “the encouragement of broader zoological interest and knowledge, formed particularly in the [Zoo].” Today, both of these continue to be FONZ’s overarching purpose, even as our organization has grown and changed immensely to meet the changing needs of the Zoo, the community, and the world’s wildlife and wildlands.

Still, FONZ retains its original character as a *citizens’* organization—and a great example of and model for civil society: people who come together voluntarily to advance the common good. As they were from the start, members of the Board of Directors are volunteers, along with about 1,800 others who donate their time and energy to the Zoo. About 40,000 individual and family members support the Zoo through dues, contributions, and participation in programs. And hundreds of others, from chefs who donate to ZooFari to corporate officials who develop partnerships between their organizations and FONZ, are part of the FONZ community of concerned citizens.

FONZ accomplished extraordinary things in its first 50 years, helping the Zoo achieve its preeminent position in the zoo community and inspiring legions of people to help save our planet. Every FONZ member and volunteer, past and present, can take some credit for changing the world. I invite all of you to celebrate your achievement, and make a commitment to continued involvement in your Zoo, at our 50th birthday party on April 12. Look for details at www.fonz.org/fonz50.htm. I hope to see you there.

Sincerely,

Bob Lamb

Executive Director, Friends of the National Zoo



is the dedicated partner of the Smithsonian’s National Zoological Park. FONZ provides exciting and enriching experiences to connect people with wildlife. Together with the Zoo, FONZ is building a society committed to restoring an endangered natural world. Formed in 1958, FONZ was one of the first conservation organizations in the nation’s capital.

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Smithsonian National Zoological Park is located at 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537. Weather permitting, the Zoo is open every day except December 25. For hours and other information on visiting the Zoo, go to www.fonz.org.

Membership in FONZ offers many benefits: programs, publications, discounts on shopping and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, FONZ, P.O. Box 37012 MRC 5516, Washington, D.C., 20013-7012, call 202.633.3034, or go to www.fonz.org/join.htm.

Membership categories and annual tax-deductible dues are:

Household	\$55
Young Professional	\$40
Individual	\$40
Senior	\$35
Contributing	\$100
Patron	\$250
Sponsor	\$500
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ZooGoer (for those outside a 200-mile radius of Washington, D.C.)	\$30 (\$8 of membership dues goes to a <i>ZooGoer</i> subscription)

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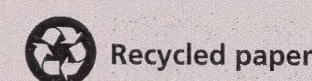
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An audio version of *ZooGoer* is available on our website, for members who cannot read standard print due to disability. For more information, please visit www.fonz.org/zoogoer.htm.

On the cover: The dyeing poison dart frog (*Dendrobates tinctorius*) inhabits lowland rainforest in northern South America. Photo by Jessie Cohen/NZP.



The Smithsonian’s National Zoo is accredited by the Association of Zoos and Aquariums.



Fighting Fire



When I became Director of the Smithsonian's National Zoo two and a half years ago, one of the first things I noticed was how ill prepared the Zoo was to prevent or combat fire. Most parts of the Zoo lacked alarms, sprinklers, and other basic equipment; the equipment that did

exist was in many cases inefficient or outdated. (Of course, all of our buildings were constructed according to fire codes applicable at the time, and with each renovation changes were made to meet any new regulations. Some of our buildings, however, have never been renovated or were last renovated long ago.)

I have many responsibilities as Director, but my primary responsibility is to ensure the safety of our staff, animals, and visitors. That is why I have made fire safety my top priority for the National Zoo in the coming years—and it will be a gargantuan task to bring the Zoo up to modern fire-readiness standards.

Within the Zoo's 163 acres sit more than 80 buildings, served by several inadequate water resources and a patchwork system of fire alarms and smoke detectors. All of them are in great need of updating. In short, the National Zoo is in dire need of a dramatic and complete fire-prevention overhaul.

I am happy to say, however, that in the short time I have been with the Zoo we have made great strides. We completed a comprehensive assessment of the Zoo's current fire-prevention system and policies, identified needs, and began work on improvements. Armed with the assessment's results, we created a new fire-prevention plan that addresses alarms, water supply, sprinkler systems, and smoke-evacuation systems. And we are in the design phase of equipping all of the Zoo's main buildings with fire and smoke-detection alarms.

We will soon begin work on updating the Zoo's water supply system. The first and main part of this phase of renovation will be the installation of a modern water main that will supply our veterinary hospital, science building, and the lower half of the Zoo's public area with adequate water pressure—something that is lacking currently. This project will take many months and will be an inconvenience to our staff, visitors, and, at times, our neighbors. But it is absolutely critical if we are to make the National Zoo a safe and sound institution.

Updated sprinkler systems—something lacking in most of our buildings—will follow as soon as possible after the completion of the water-main work. Once we have the proper support systems, such as adequate water pressure, the next challenge is to balance the schedules and needs of the renovation work with those of our visitors and animals.

It is important for us to keep as many of the Zoo's animals and exhibits accessible to the public as possible; at the same time, it is imperative to get the sprinklers and smoke-evacuation systems installed as quickly and efficiently as possible. This may result in much of the work being done outside the Zoo's normal operating

hours, but some restricted access to animals and exhibits seems inevitable.

We have also taken significant measures to prevent fires, such as becoming a non-smoking zoo. This decision was not based on health concerns but rather on fire prevention concerns—we had several incidents of carelessly discarded cigarette butts starting small fires in mulched areas.

In 1950, the National Zoo became the proud home of America's best-known ambassador for forest-fire prevention—Smokey Bear. The black bear cub, which was orphaned in a New Mexico forest fire and rescued by fire fighters, soon became so popular and received so much mail that he was granted his own zip code. People came to the Zoo then to learn about

and appreciate their role in preventing forest fires. How ironic that we now find ourselves in such dire need of enhancing fire safety “in our own backyard.” And that is why I, and everyone at the National Zoo, place fire safety so high on our list of urgent tasks. However inconvenient, completing this work is critical. It is not only our goal, but also our responsibility to make sure that we provide a fun, fascinating, and safe place for people to visit and work, and for our animals to thrive.



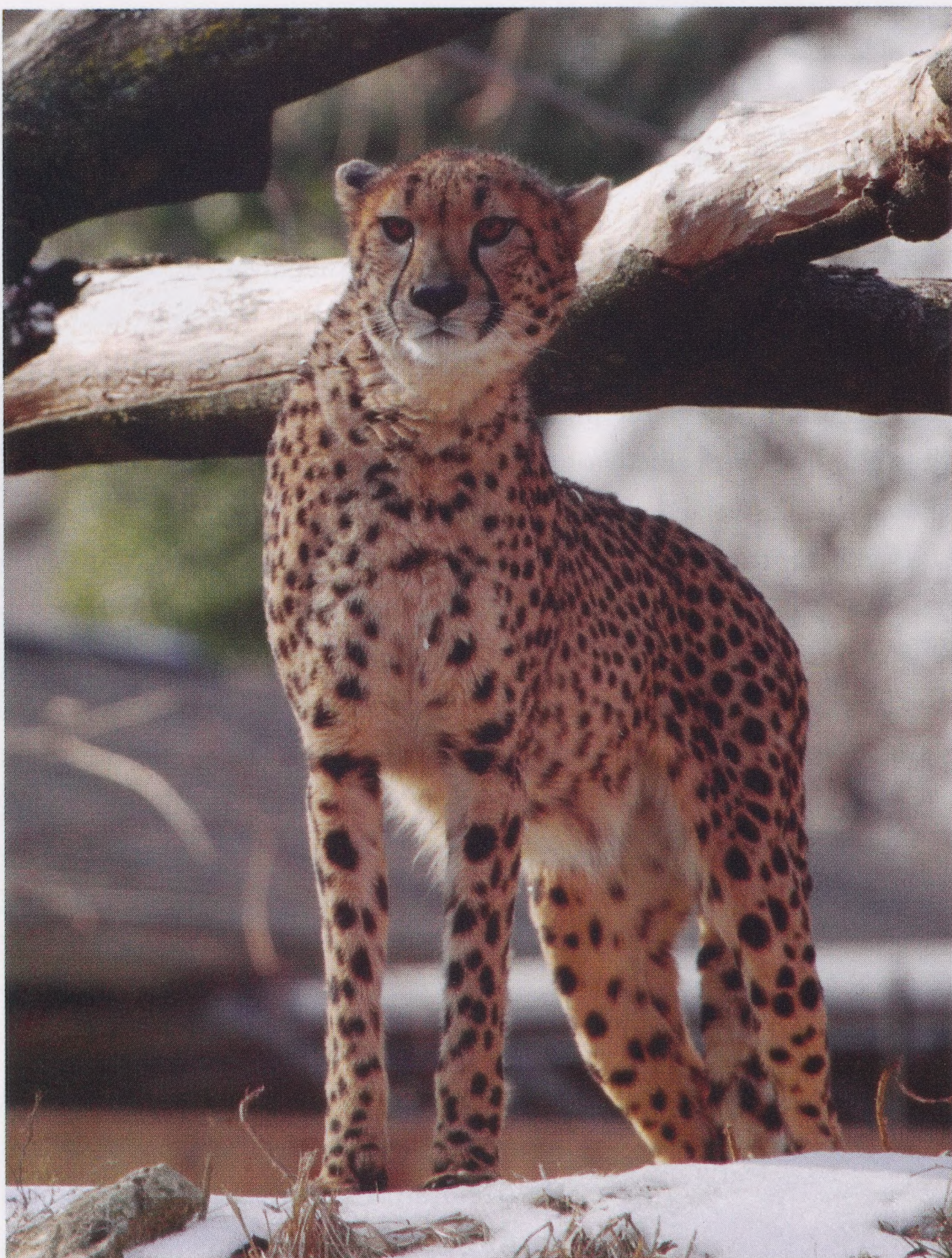
Smokey Bear.

Jessie Cohen/NZP

Sincerely,

John Berry

Director, Smithsonian's National Zoological Park



Animal News

New female sloth bear (*Melursus ursinus*) Kahli arrived from the Woodland Park Zoo on November 27. During the winter, she was gradually introduced by scent and sight to Merlin, one of the Zoo's two male sloth bears. By mid-February, both bears were spending time together each day.

Another important introduction is underway, involving the Zoo's new two-year-old female cheetah (*Acinonyx jubatus*) Amani, who arrived in late December from Wildlife Safari in Winston, Oregon. The band of brothers Draco, Granger, and Zabini have been getting a slow visual and olfactory introduction to their potential mate, via distant views and a fecal sample from Amani placed in their yard. Zoo husbandry staff are monitoring the cats' behavior closely during these introductions and look forward to introducing her to one or more of them when the time is right.

On January 16, the Zoo's pygmy falcon (*Polihierax semitorquatus*) pair became parents of their first chick, the first pygmy falcon hatched at the Zoo since 2000. The size of a mockingbird, pygmy falcons live in eastern and southern Africa. They often nest in weaverbird colonies, sometimes feeding on their hosts or their young. Females are typically larger and more colorful than males. Zoo visitors may be able to see the chick and its parents on exhibit in March.

Three cheetah brothers have noticed Amani, a newly arrived female.

Lectures and Film

These free lectures and films take place in the Smithsonian's National Zoo Visitor Center auditorium. For more information and to RSVP, go to www.fonz.org/lectures.htm.

Combating Global Wildlife Trafficking

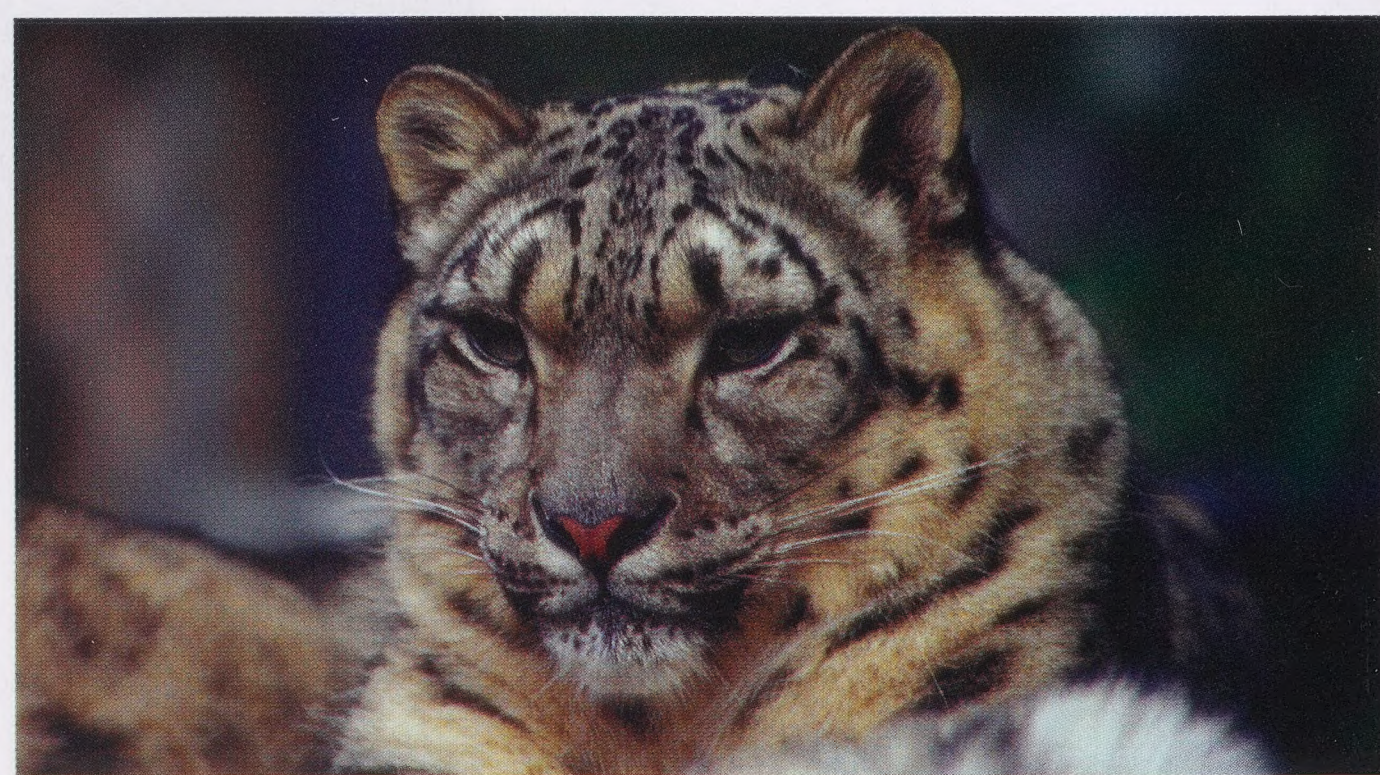
Thursday, March 6, 7 p.m.

Global illegal wildlife trade is organized crime worth an estimated \$10 to \$20 billion per year. This criminal activity is helping drive tigers, clouded leopards, elephants, and many other species toward extinction. Steve Galster, who directs Wildlife Alliance's Thailand program and has conducted undercover wildlife crime investigations around the world, will talk about his decades-long struggle to work with governments to expose and combat poachers, traffickers, and their accomplices. Please join us for light refreshments at 6:30 p.m.

Silent Roar

Thursday, March 13, 7 p.m.

In cooperation with the D.C. Environmental Film Festival, we will screen *Silent Roar: Searching for the Snow Leopard*, a beautiful film showing for the first time snow leopards hunting, courting, and even mating in their high Himalayan haunts. Introduced by National Zoo cat expert John Seidensticker.



Snow leopard (*Uncia uncia*).

Migratory Songbirds: Canaries in the Mine?

Thursday, April 24, 7 p.m. book signing, 7:30 p.m. lecture

As part of Bird Fest 2008, Bridget Stutchbury will sign copies of her book, *Silence of the Songbirds*. A leading expert on migratory birds, Stutchbury will talk about how she follows songbirds to Latin American wintering grounds and back to North American breeding grounds in an attempt to learn more about the challenges these tiny but long-distance travelers face along the way.

Events

At the Zoo, March means not only warming weather and the return of plentiful blooms, but also the kickoff of a varied series of events. For more information, visit www.fonz.org/events.htm.



Hooded warbler (*Wilsonia citrina*).

African-American Family Celebration

Easter Monday, March 24, 10 a.m. to 4 p.m.

For more than 100 years, families from Washington's African-American community have visited the National Zoo on Easter Monday to socialize and celebrate the holiday. On Monday, March 24, the Zoo will once again welcome families with a variety of activities and entertainment.

Grapes with the Apes

Thursday, April 10, 6 to 9 p.m.

Sample wines from Virginia and Maryland wineries and hors d'oeuvres from area restaurants, and enjoy live music, wine seminars with a local expert, and exclusive evening access to the Zoo's Great Ape House. Ticket price includes all wine samples, food, entertainment, and a commemorative glass. Proceeds will benefit the Zoo's conservation efforts. You must be 21 or older to attend. Tickets are \$40 for FONZ YP members and \$55 for nonmembers.

FONZ's 50th Birthday Celebration

Saturday, April 12

FONZ was created in April 1958 by a group of private citizens interested in supporting the National Zoo and its conservation and education mission. On Saturday, April 12, we will celebrate FONZ's rich history as a community-based conservation organization. See www.fonz.org/fonz50.htm for more information.

Earth Day Celebration

Saturday, April 19

The Zoo and FONZ will commemorate Earth Day 2008 with a celebration on Saturday, April 19. See www.fonz.org/events.htm for more information.

"Bird Fest"—An International Migratory Bird Day Celebration

Saturday-Sunday, April 26–27, 10 a.m. to 4 p.m.

Celebrate the return to North America of millions of

birds that winter in Latin America and the Caribbean at "Bird Fest," the National Zoo's annual celebration of International Migratory Bird Day. For more information, go to www.fonz.org/birdfest.htm.

Smithsonian Ornithology's "Big Day"

Saturday, May 3—All Day

This all-day bird count in the District is a way for local and regional bird clubs to raise funds for bird-related research. If your club is interested in forming a team, please contact Greg Gough at the Smithsonian Migratory Bird Center at goughg@si.edu. You can also help by pledging to support the Smithsonian Ornithology team at sio.si.edu.

Guppy Gala

Friday, May 9, 6 to 8:30 p.m.

Guppy Gala features live performers, many family-oriented activities, educational and informational booths, and a variety of foods. Favorite activities include a mock construction site, rock-climbing wall, moon bounces, and an obstacle course. Kids can also enjoy strolling musicians, jugglers, dancers, and costumed characters. Proceeds benefit public education programs at the Zoo. For more information, go to www.fonz.org/guppy.htm.

National ZooFari 2008

"Frogs and Friends"

Thursday, May 15, 6:30 to 10 p.m.

FONZ's marquee fundraising event, National ZooFari is a casual, exciting evening of gourmet foods, fine wines, and fabulous entertainment. Each year, thousands of guests enjoy delicacies prepared by master chefs from more than 100 of the D.C. area's finest restaurants, as well as wine served by vintners from around the world. Live music, animal encounters, a sweepstakes, and a silent auction round out a magical evening under the stars. This year's event celebrates the Year of the Frog and FONZ's 50th birthday. Proceeds from ZooFari benefit a variety of programs at the National Zoo. For more information, check out www.fonz.org/zoofari.htm.

On Our Website

You can get animal updates, learn about wildlife and conservation, and get the inside scoop from animal keepers, curators, veterinarians, and scientists on our website. Visit www.fonz.org/zoogoer.htm to:

- Read the Tiger Cub Diary.
- Find out the latest on the Zoo's lions.
- Spy on the Zoo's Asia Trail celebs—bears to otters—via web cam.
- Check out the Smithsonian Migratory Bird Center's Bird of the Month feature.
- Check out and order animal sound ringtones for your cell phone at the only place where such a purchase supports the National Zoo: www.fonz.org/ringtones.htm.

Correction: In the January/February 2008 feature "Restoring Ruined Wetlands," the Syr Darya sturgeon was misidentified as *Scaphirhynchus platyrhynchus*. The correct scientific name is *Pseudoscaphirhynchus fedtschenkoi*.

jumping




into trouble

by Howard Youth

In Mark Twain's short story "The Celebrated Jumping Frog of Calaveras County," gambler Jim Smiley puzzles over why his prize frog, Dan'l Webster, loses a frog-jumping match. After an unscrupulous challenger secretly stuffs Dan'l full of quail shot, Smiley says, "I do wonder what in the nation that frog throw'd off for—I wonder if there ain't something the matter with him." Today, this victimized, fabled frog provides a poignant metaphor for the fate of real-life amphibians—not just in the mid-1800s Gold Rush town

of Angel's Camp, California, where Twain set his tale, but well beyond.

The largest frogs around Angel's Camp in 1850 would have been California red-legs (*Rana aurora draytonii*), also one of the U.S. West's largest. Today, you won't find any there. Since the Gold Rush, these dark-backed, rosy-legged amphibians have disappeared from 70 percent of their former range. In 1996, they hopped onto the U.S. Fish and Wildlife Service's (USFWS) Endangered Species List.



A strawberry poison dart frog (*Dendrobates pumilio*) nestled in cup fungus in Costa Rica.



Tiny duckweed plants partially conceal this American bullfrog, an amphibian famed not only for its size but also its appetite for other frogs.

With this foundering frog and thousands of others, scientists and conservationists find themselves more or less in Jim Smiley's shoes, trying to figure out what's wrong with their beloved amphibians. Over the last 20 years, herpetologists around the globe have joined forces to track frogs' whereabouts, assess their well-being, and try to stem a rising tide of extinctions and declines that tugs at the complex natural fabric of ecosystems. But they have only gotten so far.

Frogs are sensitive creatures. Because they have permeable skin and eggs and typically depend upon moist habitats, they and other amphibians are particularly vulnerable to environmental changes. But most frog species remain poorly studied, so we can only guess at why many are in trouble. And as frogs vanish, new species are just being discovered.

The California red-legged frog's tale illustrates the multiple threats frog species face. In the late 1800s, an estimated 80,000 wild frogs were carted off each year to California markets to fill the bellies of recently moneyed forty-niners and San Franciscans. Overharvesting was followed by widespread habitat loss, as farms and towns changed the landscape. By the early 1900s, wild frog populations dwindled but commercial frog-farming ventures attempted to meet the demand for frog legs. Instead of stocking native red-leggeds, though, businesses imported the largest frogs native to central and eastern North America, American bullfrogs (*Rana catesbeiana*). These robust amphibians, like the miners before them, came West and found

great opportunity. Escaped farm bullfrogs, followed by those released by farmers, game-fish stockers, and frog-lovers, established wild western populations that competed with native species. They easily gained ground, often ate their competitors, and likely introduced new pathogens lethal to native frogs. In 1928, inspired by the Twain tale, Angel's Camp townspeople started an annual frog-jumping event. This tradition has kept thousands of captured and released bullfrogs busy ever since.

An Ancient Line in Decline

About 290 million years ago, long before the dinosaurs, a panoply of amphibians prowled the primordial muck. Among them were some of the top predators of the Permian period, including large-headed, six-foot-long carnivores in the genus *Eryops*. Today, Earth is home to about 6,000 amphibian species—frogs (including toads), salamanders (including newts), and tropical burrowing caecilians.

In sediments dating back 200 million years, paleontologists have unearthed fossils of the first known frog. Today, more than 5,200 frog and toad species, constituting more than 85 percent of amphibian diversity, inhabit all continents except Antarctica. Found not only in temperate wetlands but also above the Arctic Circle, in steamy equatorial rainforests, and even in some desert regions, they range in size from tiny Cuban and Brazilian species that fit comfortably atop a nickel to the largest, which can stretch three feet long from nose to hind toes.

In 1967, National Geographic Society scientist Paul A. Zahl wrote of his trip to equatorial Africa to encounter the world's largest frog. In words and photos, he gave *National Geographic* readers a glimpse of the goliath frog (*Conraua goliath*), which had been first described six decades earlier. Zahl concluded his article by pondering the species' future:

...the generous proportions of a goliath drumstick put it in a class by itself. Such appeal could quickly doom these rare animals, were it not for two circumstances: their preference for difficult terrain, and the sparseness of human population to prey upon them. Unless these factors change, their survival seems assured.

Today, the goliath is listed as endangered on the World Conservation Union's (IUCN's) Red List, and its numbers are estimated to have declined by more than half over the last 15 years. Restricted to fast-flowing jungle rivers and streams in Cameroon and Equatorial Guinea, the frogs are now trapped and carried off for sale in urban food markets. In addition, each year at least several hundred are exported by zoos and animal traders.

Most scientists agree that Earth is undergoing its single largest mass extinction event since the catastrophic demise of dinosaurs 65 million years ago. Goliath and other frogs are among the fastest-falling victims. Since frog species began vanishing in the late 1980s, scientists have galvanized their efforts to track these diverse creatures, with sobering results. The Global Amphibian Assessment (GAA), the product of input from nearly 600 experts in more than 60 countries, first came out in 2004 and has yielded the first-ever worldwide snapshot of more than 5,900 amphibians species' conservation status and distribution. This regularly updated inventory reveals that nearly one-third of existing amphibian species are threatened, compared with 12 percent for birds and 23 percent for

Critically endangered by habitat loss and over-collection, the golden mantella (*Mantella aurantiaca*) is found in an area of Madagascar not much larger than that encompassed by Rock Creek Park.

Jessie Cohen/NZP



mammals, the only other groups that have been subjects of global assessments. The GAA estimates that at least 43 percent of amphibian species are in decline, although about 30

percent could not be determined due to lack of data. Just one-half percent were ranked as increasing. Experts also believe that as many as 165 frog species have gone extinct, with at least 122 of these vanishing since 1980.

A 2005 conservation summit convened by the IUCN Species Survival Commission helped further hone scientists' and conservationists' efforts to study and reverse declines. The summit yielded a 2007 Amphibian Conservation Action Plan, a comprehensive, global plan that outlines strategies for responding to amphibian losses. Individual country efforts have aided this mission. For example, U.S. Geological Survey (USGS) scientists have collaborated on an Amphibian Research and Monitoring Initiative since 2000 to address U.S. amphibian population slumps, and the agency recruits volunteers and other collaborators for a long-term project called the North American Amphibian Monitoring Program. And this year, the Amphibian Ark—a program that highlights zoo efforts to save rare frogs—was launched as part of the IUCN's and the World Association of Zoos and Aquariums' global Year of the Frog campaign.

The Smithsonian's National Zoo is participating in the Year of the Frog. Educational activities and exhibits will take place throughout 2008, aimed at creating awareness in Zoo visitors and inspiring them to take action to save amphibians locally and globally. Also, the Zoo is breeding imperiled frogs, and scientists and keepers there hope to expand frog breeding programs in coming years.

Wet, Waning, and Wasted

The greatest overall threat to frogs and other amphibians is habitat loss and degradation, which adversely affects about 4,000 species. A look at small countries with growing human populations and few remaining wild areas illustrates how amphibians and other wildlife are running out of space. In the Caribbean, for example, more than 80 percent of amphibian species in the Dominican Republic, Cuba, and Jamaica are threatened, while in impoverished, deforested Haiti, 92 percent are in trouble.

Particularly in the tropics, frog diversity and distribution remain poorly studied. As trees fall and wetlands shrink, scientists find new frog species while others disappear. Up until the late 1990s, for example, fewer than two dozen frog species had been catalogued in the Asian island nation of Sri Lanka. Over the past nine years, however, following boosted efforts to census and classify frogs there, the count jumped to beyond 100 species. No one can know how many other frogs once occurred on the West-Virginia-size



Steve Snyder/iStockphoto.com

island. But following decades of deforestation, it is certain that at least some known species have recently been lost, along with more than 95 percent of the original forest cover. In 2005, for example, scientists from Sri Lanka's Wildlife Heritage Trust documented 35 new frog species, but also found that 19 previously described species had gone extinct.

Plenty of habitat has also disappeared in temperate regions, including the United States. Since European settlement, widespread wetland losses undoubtedly slammed many U.S. frog populations, although data are not available for earlier years when the largest losses occurred. By 1980, California and five Midwest states had lost more than 95 percent of their original area in wetlands; 16 other states had lost between 50 and 95 percent. Today, the USFWS lists 21 amphibian species as threatened or endangered. The GAA, however, tallied 51 U.S. species as threatened, and 32 as nearly threatened. Three species are listed as extinct.

Chemical pollution poses another threat to frogs. For example, atrazine, one of the most commonly used herbicides in the world, is considered an endocrine disruptor—a substance that can alter

At least some deformities in Pacific treefrogs (*Hyla regilla*), shown here, and other frogs appear to be caused by microscopic parasites called trematodes.



Desert spadefoot toads (*Notaden nichollsi*) live in arid western Australia.

the sexual reproduction and development of creatures exposed to it. In their article published in the *Proceedings of the National Academy of Sciences* in 2002, a team of biologists wrote that “hermaphroditic, demasculinized” African clawed frogs (*Xenopus laevis*) resulted after larvae were exposed to “realistic exposures” of atrazine. Frogs exposed at “low ecologically relevant” doses of the compound developed both male and female sexual organs. In males, exposure also drove down testosterone levels. The authors suggested that similar exposures in wild frogs could risk impairing the frogs’ sexual development. “This widespread compound and other environmental endocrine disruptors,” they wrote, “may be a factor in global amphibian declines.” Elsewhere, tests using northern leopard frogs (*Rana pipiens*) found that exposure to small amounts of atrazine yielded similar results, altering the frogs’ ability to breed.

Other agricultural and industrial chemicals kill or injure frogs. A study released in 2007 by scientists from the University of Colorado at Boulder fingered boosted levels of nitrogen and phosphorus, chemicals commonly used in fertilizers, as responsible for spikes in the rate of frog deformities. These chemicals spur algae growth, which helps snail populations increase and spread rapidly. The snails may indirectly spur debilitating frog deformities because they host microscopic parasites called trematodes, which form cysts on tadpoles that can cause disfigurement. Deformed frogs may not live as long as usual, and their breeding may be impaired. Other studies point to a link between an increased rate of trematode infections following pesticide exposures, hinting that animals’ immune responses may be altered by the chemicals. The potential dangers posed by agricultural and industrial chemicals to amphibians remain largely unexplored.

Invisible Killers

Scientists also suspect that recent environmental changes across the globe affect amphibians. Threats include increased acidity of water in areas affected by acid rain and rising levels of ozone, perhaps caused by the erosion of the ozone layer. Also, shifting



Global climate shifts may be creating the “perfect storm” for the spread of pathogens that kill frogs.

patterns of precipitation, cloud cover, and temperature resulting from global climate change seem to be taking their toll. Although people tend to think of global warming as a phenomenon that primarily affects temperate and polar areas, it also seems to be having a strong impact in the tropics. A 35-year study of lowland forest habitats at the La Selva Biological Station in northern Costa Rica, for example, recently revealed that all terrestrial amphibians, along with lizards, declined by an average of 75 percent within the protected study area. The investigators believe that global warming is to blame—that with warmer temperatures, trees hold their leaves longer and/or decomposition rates are higher. The overall effect is a reduction in leaf litter, which denies ground-living amphibians and reptiles critically important food and shelter.

Global climate shifts may also be creating the “perfect storm” for the spread of pathogens that kill frogs. A recent survey of forest-dwelling Neotropical toads called harlequin frogs (*Atelopus* spp.) found that while only a few species have been affected by habitat loss, 81 percent of adequately studied species are in decline. Only ten species have healthy populations. Of the 113 harlequin frog species of Central and South America, at least 30 have vanished in the last 20 years.

“Our findings point to *Atelopus* as the most striking case of catastrophic species loss ever documented for a single amphibian, or perhaps vertebrate, genus in recent history,” wrote a scientist from the Smithsonian Tropical Research Institute on Barro Colorado Island, Panama, and his international colleagues in the journal *Biotropica* in 2005.

The reasons for these disturbing declines are still not entirely clear, but scientists think that two major suspects, a fast-spreading fungus called chytrid and quick-changing climate, might be working together. “Disease is the bullet that’s killing the frogs,” said biologist J. Alan Pounds of the Golden Toad Laboratory for Conservation in Puntarenas, Costa Rica. “But climate change is pulling the trigger.” In a 2006 study published in the journal *Nature*, Pounds and his colleagues noted a correlation between chytrid and rising temperatures, which leads to more cloud cover that cools days and warms nights in tropical mountain forests. This temperature moderation may spur the spread of the chytrid fungus. Alternatively,



The red-eyed treefrog (*Agalychnis callidryas*) is a common rainforest inhabitant from southern Mexico to Panama.

Sascha Burkard/iStockphoto.com

climate change may stress frogs, making them more susceptible to the fungus or other diseases. This is but the latest twist in a disease-sleuthing saga that began about 20 years ago. In the late 1980s, Pounds and other herpetologists noted some of the first disturbing drops in frog numbers, in Monteverde Cloud Forest Reserve, a protected mountain area in Costa Rica. The standard culprits—habitat loss, pollution, introduced predators—didn’t figure there. An invisible killer was at work. In 1999, National Zoo pathologists were at the forefront in isolating this microscopic fungus and the associated fatal disease, chytridiomycosis, which they found while analyzing blue dart-poison frogs (*Dendrobates azureus*) that had died at the Zoo. “It was a unique skin disease unlike anything I’d seen before, with these round, microscopic organisms,” recalls one of the investigators, former Zoo pathologist Don Nichols.

Although named less than ten years ago, the chytrid fungus *Batrachochytrium dendrobatidis*, or *Bd* for short, has since been detected in frog species in the Neotropics, Australia, North America, and other parts of the world. In lab tests, the fungus and its resulting illness killed frogs of most of the tested species. In the tropics, *Bd* seems to flourish at higher elevations, and lab studies indicate that in general it may be most virulent in cool, moist areas.

Seventy-five percent of the harlequin frog species restricted to high elevations have vanished, according to the 2005 *Biotropica* article. Among extinct species, chytrid was recorded in populations for an average of three years before all individuals vanished.

Where did the chytrid fungus come from? Some research suggests it originated in Africa; other recent evidence suggests a North American strain exists.



A natural match for its surroundings, the mossy frog (*Theloderma corticale*) leads a sheltered life on craggy forested mountain slopes in northern Vietnam.

Jessie Cohen/NZP



Young and adult Panamanian golden frogs, members of a critically endangered species bred at the National Zoo.

It may have been spread by introduced game fish or frogs. The African clawed frog, for example, is widely sold in pet stores, and has been shipped all over the world for use in medical tests since the 1930s. Released individuals may have carried the fungus—and more—to wild areas. For example, in southern California, where this species now has self-sustaining wild populations, scientists found infestations of two parasitic worms previously known only from Africa. In addition to preying upon native amphibians, introduced bullfrogs and game fish such as trout may have helped spread the fungus and other parasites and illnesses to the western U.S., South America, and other parts of the world.

Some experts hypothesize that scientists or ecotourists might have transported the fungus to new areas on their equipment or boots. Biologists studying frog populations now disinfect their gear before moving from one study site to the next, but in the 1980s and earlier, such a practice was not commonplace.

If habitat protection alone cannot save amphibians, what can be done? In zoos and aquaria, certain treatments seem to help frogs survive chytrid infections. One of the more recent findings came from New Zealand, where scientists learned that chloramphenicol, a medicine used to treat human eye infections, cures frogs of the fungus.

The National Zoo continues to play a part in helping save endangered frogs. Critically endangered Panamanian golden frogs (*Atelopus zeteki*) breed in the Zoo's Reptile Discovery Center, contributing to a reservoir of zoo genes that can help ensure that these diminutive hoppers do not follow some of their brethren into extinction. They are

the *Biotropica* investigators wrote of the harlequin frogs, "These population changes are expected to cascade through aquatic and terrestrial food webs, with often unexpected consequences."

Playing key roles as hunter and hunted in a variety of habitats, frogs are important cogs that keep nature's gears smoothly turning.

now probably extinct in the wild due to habitat loss, overcollecting, and chytrid fungus.

While zoo breeding may not be able to save all *Atelopus* species, as the *Biotropica* authors wrote: "At present, two likely causes for population declines, *Bd* and climate change, cannot be counteracted in wild [*Atelopus*] populations. The only conservation tool available when either of these two factors is present is *ex situ* breeding programs."

It's a Frog's Life

Despite all the attention now focused on amphibian declines, scientists have just started teasing apart the vexing mysteries of disappearing frogs. This work relates not just to frogs themselves, but to their ecosystems. As

Scientists' detective work is stymied by the complexity of frog natural history. For example, frogs have varied breeding strategies. We are familiar with pond- or pool-breeding frogs, which lay eggs in water, and the young hatch as tadpoles before metamorphosing into adults.

But almost half of all frogs follow different pathways to adulthood. Some carry their eggs on their back legs, and some lay eggs in trees and their tadpoles fall into water below when they hatch. Some tropical frogs, such as Solomon Island leaf frogs (*Ceratobatrachus guentheri*), which are exhibited in the Zoo's Reptile Discovery Center, skip the tadpole stage and hatch directly into small froglets.

These Solomon Island leaf frogs hatched at the Zoo in 2007. The species forgoes a tadpole stage, so tiny froglets emerged from eggs.





Frans Lanting/lanting.com

A clown tree frog (*Hyla leucophyllata*) in its Peruvian rainforest habitat. The greatest overall threat to frogs is habitat loss and degradation.

Also, there's no single, surefire way to survey these jumpy creatures. It's not like counting crows for a Christmas bird count or looking for singing orioles for a spring breeding bird survey. While many frogs have loud voices that can be heard during their breeding season, they don't breed on such predictable schedules as do most birds of temperate climates. Instead, they must wait until moisture levels and other environmental conditions are ideal. Some frogs have brief breeding periods, others have long ones. And frog populations frequently undergo dramatic natural ebbs and flows. Compounding the difficulty, species that live in rainforests and other densely vegetated habitats often avoid detection. The well-studied genus *Atelopus* is an exception: The majority of the species are brightly colored, diurnal, and found along stream edges.

Playing key roles as hunter and hunted in a variety of habitats, frogs are important cogs that keep nature's gears smoothly turning. They also remain the important focus of human lore and interest, as in the former mining town of Angel's Camp, California.

These days, in the protected habitats where they survive, California red-legged frogs face more than bullying bullfrogs. In some areas, chytrid fungus, trematode parasites, and introduced and hungry African clawed frogs are added dangers.

With permeable skin and eggs and ties to wet habitats, frogs such as this glass frog (*Hyalinobatrachium* sp.) in Ecuador are sensitive to environmental changes.



Meanwhile, the show must go on in Angel's Camp. Each year, up to several thousand bullfrogs compete, spurred on by their handlers. The capture, trade, and rerelease of bullfrogs is carefully monitored by fair organizers and state wildlife agencies so as not to affect any of the remaining red-legged frog populations outside of town. Not that the thousands of transported bullfrogs would follow rules given the chance: USGS scientists studying introduced bullfrogs in the Southwest recently found that these pioneering jumpers can disperse on their own more than six miles between suitable wetland habitats.

Do people in "Frogtown, U.S.A." miss the native red-legged frog? Some say yes, others no. The naysayers resist any suggestion that native frogs be reintroduced into nearby wetlands, lest there be more restrictions on where new homes or businesses can be built, or where people can seek and release bullfrogs.

So, even where frogs are celebrated, it's a brave new world for declining amphibians. And in this shaky, human-dominated world, it seems that only the most adaptable can keep their heads above water. Z

—Contributing editor Howard Youth last wrote about declining amphibians in *ZooGoer* in the March/April 2000 issue.



Despite strict protection, sea otters remain vulnerable to diseases originating both on land and sea, submerged box traps, and in areas such as Monterey Bay, malnutrition.

California Sea Otters,

adrift

by Robin Meadows

Sea otters once ranged all along the Pacific Rim, from Baja California, Mexico, to Japan. But beginning in the mid-1700s, these marine mammals were hunted commercially for their soft, dense fur. Otters were easy targets because they rest in large groups called rafts. To stay together, they tangle themselves in kelp or hold paws with their neighbors. Rafts may have hundreds of otters, and one in Alaska was reported to have at least 2,000 otters. By the time sea-otter hunting was finally banned by the 1911 International Fur Seal Treaty, it was almost too late. Except for perhaps a thousand scattered in Alaskan waters, the otters were all gone.





A young California sea otter rests in floating kelp. The threatened California subspecies has limped along under legal protection, slowly growing to about 2,800 individuals.

Or so it was thought. In 1938, a small population of the California sea otter (*Enhydra lutris nereis*), a subspecies that lives off the central coast of California, was rediscovered off Point Sur, 15 miles south of Carmel. But instead of flourishing under legal protection like those in Alaska and another population in the Pacific Northwest, the California otters limped along for decades. Listed as threatened in 1977, the California population has reached only a precarious 2,800 or so, and disease-ridden otter carcasses are washing up on beaches flanking their range. Alarming though this is, a new study spearheaded by Smithsonian's National Zoo scientists suggests that disease may not be the otters' only—or even their worst—problem.

The last big scare for the California sea otter was in the mid-1970s, when the rediscovered population reversed its slow but steady increase. The culprit turned out to be gillnets. Otters dive as deep as 100 meters (about 330 feet) for sea urchins, abalones, and other prey that live in kelp forests and on the sea floor, and back then gillnets were set in such shallow waters that they caught otters as well as fish. Once California banned nearshore gillnet fisheries in 1985, the otter population resumed its gradual climb and grew from about 1,300 to about 2,300 over the next decade. But the otters began declining again in the mid-1990s and although they are now slowly rising again, they are still in trouble. This time the reasons for their woes are far more complex, making another easy fix unlikely.

Pioneering Parasites

Clues as to what's wrong come from the 3,100 beach-cast sea otter carcasses that have been collected by the state of California since 1968. These beach-casts do not necessarily reflect the population as a whole, in part because just as many carcasses sink or wash out to sea. And more than two-thirds of them are too decomposed to necropsy. Overall, only about 15 percent of California sea otter deaths are explained.

That said, fresh carcasses provide an amazing degree of insight into the causes of death. Roughly half of the beach-cast otter deaths are attributed to infectious or parasitic diseases, a discovery that made a huge media splash because sea otters are not natural hosts for many of these parasites. Up to 18 percent of the necropsied otters have brain infections of *Toxoplasma gondii*, a parasite whose primary hosts are domestic cats and other felines. Others have brain infections of *Sarcocystis neurona*, a parasite whose primary host is the Virginia opossum (*Didelphis virginiana*). These two parasites spread via the feces of their hosts, and together they killed nearly a quarter of otters autopsied between 1998 and 2001.

The idea that land is the source of the California otter's ills is bolstered by several other observations. For example, some otters have industrial chemicals such as DDT and PCBs in their blood, and a 2003 spike in otter deaths was attributed partly to toxic algal blooms, which can be triggered by fertilizer runoff. This all adds up to the widely accepted "dirty ocean" hypothesis, which posits that otters are

dying because they are swimming in a soup of nasty pathogens and toxic compounds pouring from the land into the sea.

Dire as this hypothesis sounds, it is also somewhat comforting. Although the implication is that we are killing sea otters, the flip side is that we can also help them by cleaning up our act. In keeping with this viewpoint, a 2006 bill called AB 2485 requires labeling kitty-litter packages to discourage pet owners from flushing litter that is used, and possibly parasite-laden, down the toilet.

However, some of the new parasites killing sea otters come from the ocean. One of the best examples is thorny-headed worms (*Profilicollis* spp.). These parasites typically infest mole crabs and shorebirds, and were quite rare in sea

otters 40 years ago. But now thorny-headed worms are infesting otters in massive numbers, ultimately perforating their intestines and killing 14 percent of those autopsied between 1997 and 2001.

Trapped?

About 85 percent of California sea otter deaths remain a mystery, leaving plenty of room for non-disease causes. One big unknown is the impact of the “live fish” fishery that has boomed in California since the early 1990s, coinciding with the onset of the latest sea otter decline. This lucrative fishery caters to sushi restaurants, Asian food stores, and other markets that place a premium on freshness. Targeting rockfish and other bottom-dwelling species, the fishery sets box traps on the sea floor where otters hunt for prey. Box traps are essentially cages that let fish swim in but not out, and they are big enough to catch and drown otters.

Otters are curious animals and in aquarium studies, they readily entered these traps. When they die at box-trap depths, their carcasses are likely to stay underwater rather than washing ashore. This is because, unlike whales and other marine mammals insulated by a layer of blubber, sea otters are insulated by a layer of air held by their exceptionally fine fur. When the fur is no longer groomed, the air bubbles out and the carcass loses its buoyancy. Box-trap-drowned carcasses that do eventually wash ashore are likely to be too badly decomposed to necropsy.

What's in a Diet?

Malnutrition has also been a suspect in the species' decline, and the latest research confirms that poor diets could be a major cause of otter deaths. “Conservation biologists and resource managers usually overlook this possibility due to lack of familiarity with nutritional sciences,” says National Zoo comparative nutritionist Olav Oftedal, who is lead author of the first sea

otter nutrition study. Completed in 2007, the four-year study was sponsored by the Monterey Bay National Marine Sanctuary and the Marine Mammal Commission. Oftedal's co-authors included National Zoo conservation biologist Katherine Ralls and Tim Tinker, a sea otter expert at the University of California, Santa Cruz.

Sea otters are big eaters, consuming 25 percent of their body weight or more each day. This adds up to a lot of seafood, considering that females weigh about 45 pounds and males weigh about 65 pounds.

Not surprisingly, California's sea otters are infamous for overfishing their favorite prey, especially energy-packed sea urchins.

The idea that California otters are running out of high-quality prey sprang from several lines of evidence. Although the

population size is now growing again, the increase masks a troublesome pattern: Most of the current increase is in the southern tip of the range, while otters in the center of the range are declining. Ralls says these central otters are at such high densities that their habitat may no longer be able to support them. In addition, the otters' range is expanding at both ends, which could mean that they are traveling farther in search of food. Adult females are also increasingly dying in the summer, when they have to eat even more than usual to nurse their pups. Emaciation or starvation contributed to the deaths of a quarter of all necropsied otters.

Oftedal, Ralls, Tinker, and their colleagues compared sea otter nutrition in the Monterey Bay National Marine Sanctuary's shrinking population to the thriving populations at Glacier Bay, Alaska, and San Nicolas Island, which is off the coast of southern California. “San Nicolas Island otters are as big and fat as otters anywhere where the population is growing fast,” says Tinker.

Sea otters are big eaters, consuming 25 percent of their body weight or more each day.

A raft of California sea otters. In Monterey Bay, individuals may eat only a few kinds of prey, perhaps a sign of intense competition for food.



Lynn M. Stone/naturepl.com

“Monterey has the scrawniest sea otters we’ve found anywhere. You can see their ribs and vertebrae when they’re diving.”

He should know. Tinker previously led a three-year study of Monterey otters that included watching 63 radiotagged adults to see what they ate. This work set the stage for the otter nutrition study with Oftedal and Ralls that was based partly on observations of about 1,600 feeding bouts, which lasted from one to four hours each and totaled about 58,000 otter dives. This extensive dataset revealed that Monterey otters have very different eating habits from the other otters studied.

In each of the thriving populations, all of the otters had very similar diets: mostly sea urchins in southern California’s San Nicolas Island, and mostly clams in Alaska’s Glacier Bay. In contrast, across the declining Monterey population, otters ate a wide variety of prey including crabs, sea urchins, clams, mussels, abalones, turban snails, sea stars, sand dollars, and worms called fat innkeepers (*Urechis caupo*). But each Monterey otter ate only a few kinds of prey, resulting in six main diet types ranging from mostly abalones and crabs, to mostly sandy-bottom prey such as clams and worms, to mostly snails. “This extreme dietary specialization suggests that competition for food is intense in this population,” says Oftedal.

Indeed, the biggest, most accessible prey have been depleted in the middle of the California sea otter’s range. “By specializing, they get good at catching and eating their prey fast so they can get

Monterey Bay sea otters devote 40 percent of their time to foraging and feeding.



Mark Newman/Bruce Coleman Inc.

When not resting on the surface, sea otters dive as deep as about 330 feet in search of food.

enough,” says Tinker. Even so, these otters are working very hard for their food. Sea otters eat every few hours around the clock, and the Monterey otters devote 40 percent of their time to foraging and feeding. Sandy-bottom specialists, for instance, can go through hundreds to thousands of mole crabs, sand dollars, and other small prey each day. Otters at the prey-rich San Nicolas Island have it much easier, spending only half as much time feeding. “All it takes are a few big red urchins, which are the size of pineapples, and a big abalone, and they’re full,” says Tinker.

San Nicolas Island otters are also exceptionally well-nourished. Sea urchins are full of fat and an energy-rich diet is just what the otters—as marine mammals without blubber—need to stay warm in the cold ocean. To find out how well the Monterey otters’ needs are met by their unusual diets, the team determined the equivalent of food-label “nutrition facts” for each of the six diet types.

The first step was gathering prey samples from a variety of coastal habitats. For example, collectors waded in tide pools for prey such as snails and abalones, dug in sand flats at low tide for prey such as mole crabs and clams, and dove into kelp beds for prey such as crabs and sea urchins. The next step was processing the prey like an otter to ensure that the nutritional analysis was as accurate as possible. Otters have specialized methods for getting at the flesh in each type of prey. For example, they smash snails against rocks on their chest, rip the arms off sea stars, and pull the pinchers and carapace off crabs.

The final step was analyzing nutrient levels by diet type and comparing them with those recommended for pet cats and dogs. Although not ideal, these domestic carnivores were the closest match the scientists could find for sea otters. “To our knowledge, our study is unparalleled for a wild carnivore,” says Oftedal.

The nutritional analysis showed that compared to domestic carnivore and San Nicolas Island otter diets, many of the Monterey otter diets are shockingly deficient. “They are all pretty bad on energy,” says Ralls. With the exception of red sea urchins, which are close to one-third fat, Monterey otter prey are extremely low in fat. The prey with the second-highest fat content, red abalones, are still much lower at about ten percent. And many of the otters’ prey have



Doc White/naturepl.com

hardly any fat at all—snails, clams, and sand dollars are less than four percent fat. Moreover, the Monterey diets are also low in vitamins. For example, all six of the diet types are low in vitamin B1, and several are low in vitamin A as well.

Worst of all is the snail diet, which was eaten by a tenth of the Monterey otters studied. In addition to being low in fat and vitamins, the snail diet is remarkably high in calcium. Otters eat snails by smashing them open, and fragments of the high-calcium shells stick to the snails' flesh. Too much calcium can interfere with the absorption of other minerals such as phosphorus and zinc, and otters on the snail diet got ten times more calcium than those at San Nicolas Island. "The snail-based diet appears to be replete with nutritional error," says Oftedal.

Besides causing otter deaths directly, malnutrition may be linked to diseases. "Deaths from disease could be a symptom of inadequate nutrition," says Ralls. It makes sense that weak, malnourished otters are more likely to succumb to diseases than strong, healthy ones. And there is some evidence that otters on the snail diet are more likely to die of the parasitic brain diseases toxoplasmosis and sarcocystis. Diets may also expose otters to "new" parasites not found in their preferred prey. For example, San Nicolas Island otters don't eat mole crabs but some of the Monterey otters do, thereby exposing themselves to the intestine-perforating worms that parasitize the crabs.

To see if diet is an underlying cause of otter diseases, Ralls wants to know what the beach-cast otters ate. Otter prey have chemical "fingerprints" in the form of specific fatty acids and stable isotopes, which can be analyzed in otter fat and whiskers, respectively. The plan is to watch what radiotagged otters eat, then analyze their fat and whiskers. If the chemical fingerprints reflect the observed diets, the scientists will know that analyzing fat and whiskers is a reliable way of showing whether particular diets are really linked to particular diseases.

Habitat Expansion

If poor diets are the primary threat to the California sea otter, cleaning up the ocean won't be enough. "Let's say we get rid of toxoplasmosis but the real problem is that the otters don't have enough to eat. Then they'll just get the next disease," says Ralls.

In that case, the otters' greatest hope would be expanding into new, prey-rich waters, but the otters face barriers at both ends of

If poor diets are the primary threat to the California sea otter, cleaning up the ocean won't be enough.

elephant seal beaches and sea lion rookeries, which are common at the northern end of the otter's range. Shark bites cause about 60 percent of beach-cast otter deaths in the ten-mile stretch of coast north of Monterey Bay.

The barrier at the southern end of the range is legal. The otters at San Nicolas Island were translocated there 20 years ago by the U.S. Fish and Wildlife Service (USFWS) in hopes of starting a second

population. California otters are vulnerable to oil spills, and having two populations would help keep a spill from wiping them all out at once. However, the shellfishing industry opposed this translocation vigorously for fear that the sea otter would outcompete them for shellfish, and in concession the USFWS designated the southern third of the state's coastline as a "no-otter" zone in 1987. Any otters that ventured south of Point Conception, which is near Santa Barbara, were to be caught and relocated.

But nothing went as planned. While the otters at San Nicolas Island are doing well, the population has never grown big enough. Many of the 140 translocated otters left and today there are only about 40 living there. In addition, maintaining the "no-otter" zone proved to be troublesome for the USFWS, so the agency stopped enforcing it in 1993. The USFWS is now in the process of declaring the translocation a failure, which could mean getting rid of, or at least reducing, the "no-otter" zone. "Containment of the southern sea otters is not consistent with the requirement under the Endangered Species Act to avoid jeopardy to the species," wrote the USFWS in a 2001 policy notice in the *Federal Register*.

Regardless of the law, sea otters have already moved south of Point Conception. Letting them continue this natural range expansion may be the best thing we can do for them. It's not a quick fix and it's not a sure thing. And it feels passive. But "the real danger is that we'll take action that won't actually help the sea otter," says Ralls. "People want to do something but it's important to do the right thing." Z

—Robin Meadows is a contributing editor to ZooGoer.



While sea otters go about their daily lives, scientists worry that poor nutrition leaves them vulnerable to diseases.

Lynn M. Stone/naturepl.com

The more scientists look, the more they find that black rhinoceroses and other animals display marked personality differences.





wild personalities

by Jessica Marshall

"Some are moderately even-tempered, and some irritable, some brave and some timid; some volatile and some phlegmatic," wrote A.T.A. Ritchie before his death in 1962. But he was not discussing the personalities of children, soldiers, or mothers-in-law. Ritchie, who served as the chief game warden of Kenya from 1923 to 1949, was referring to wild black rhinoceroses (*Diceros bicornis*).

The notion that rhinos have personalities might well seem a dubious one, but Ritchie is not alone in his attributions. People have described personality in everything from bears to birds to bugs.

Can animals really have personalities? To anyone with a pet dog or cat, the answer is, emphatically, yes; to them, the existence of animal personalities seems preposterously obvious. But many scientists are more wary. They warn against the dangers of anthropomorphism, projecting human thoughts and feelings onto animals without the ability to test objectively whether these exist. Just because an animal's mouth is wide, for example, does not mean it is smiling, which does not in turn imply that it is happy—even though we may be programmed to interpret the expression that way. For years, scientists have tread carefully around the idea that an animal might have a personality.



Upturned lips don't necessarily mean that this silverback western lowland gorilla (*Gorilla gorilla gorilla*) is happy. Scientists believe the best way to describe personality in animals is through combinations of measurable traits.

That was not always the case. The idea that animals' resemblance to humans goes further than just anatomy and physiology was fairly mainstream until the 1940s. Charles Darwin argued for emotions in animals in *The Expression of Emotions in Man and Animals*, published in 1872. "Many personality traits involve emotions. It's a very short leap from emotions to personality," says psychologist Sam Gosling, who heads the Animal Personality Institute at the University of Texas at Austin. But a negative view of animal personality research was well entrenched by the 1990s when Gosling was pursuing his graduate work at the University of California, Berkeley. His advisor actively discouraged him from studying animal personality, calling it "goofy" and reiterating that his peers would consider the work anthropomorphic.

Despite such warnings, Gosling and others have breathed legitimacy into the topic by showing that personalities can be measured in a scientific way. Personality is not just observable in

monkeys, dogs, and humans. Even fish and spiders have shown predictable personalities. The more scientists look, the more they find that animals have measurable personality differences: bold, shy, curious, sociable, aggressive, and more.

"I started out thinking animals did not have personality," Gosling says. "But the more I thought about it, the more I couldn't think of a reason why they shouldn't. I began realizing that maybe they do have personality, and maybe that can lead us in interesting directions."

What Is Personality?

It is easy to describe an individual's personality, but a scientific definition is tougher. Scientists agree that personality means more than just a single behavior, and is instead a pattern of consistent behaviors. A bold animal, for example, might consistently be quick to try new foods, explore new environments, and recover quickly after a threat. But an animal's overall personality is the combination of several such traits—its boldness, its aggressiveness, and its sociability, for example.

In humans, personality is often assessed using a five-factor test, which indicates where an individual lies along the continuums of introversion versus extroversion, conscientiousness versus impulsivity, aggression versus agreeableness, neuroticism versus emotional stability, and being open versus closed to new experiences.

By finding similarly objective measures of personality, scientists have persuaded their peers to take research on animal personality seriously. But since animals can't fill out personality questionnaires, scientists need other methods—namely behavioral observations—to make objective assessments. To do this, they must show that an animal has a reproducible set of behaviors consistent with a particular personality trait, and that its observed personality can be used to predict its behavior in a new setting.

Gosling was one of the first to prove that personality can be measured reliably in a verifiable way. He conducted experiments in the 1990s that showed that four handlers of a colony of captive spotted hyenas (*Crocuta crocuta*) consistently agreed on the animals' personalities. He extended the work to domestic dogs, using a four-factor test he developed that rates them in terms of energy versus slothfulness, affection versus aggression, trainability versus stupidity, and anxiety versus calmness. Using this scale, he found that strangers' ratings of the dogs' personalities matched those of the dogs' owners. Likewise, psychologist John Capitanio's group at the University of California, Davis, demonstrated a different

Scientists agree that personality means more than just a single behavior, and is instead a pattern of consistent behaviors.

four-factor test for primates, which included degree of sociability as one of the factors.

Other animals, like birds, rodents, and fish, also show consistent personality traits. Those that tend to be more aggressive toward their peers tend also to be bolder in exploring their environment, says evolutionary ecologist Niels Dingemanse of the University of Groningen in the Netherlands, who has studied personality in great tits (*Parus major*) and three-spined stickleback fish (*Gasterosteus aculeatus*).

One of the classic but surprising examples of animal personality is octopuses, which are solitary and are invertebrates, unlike the more obviously personable chimpanzees or golden retrievers.

Giant Pacific octopuses (*Octopus dofleini*) at the Seattle Aquarium, for example, have had such dramatically different personalities that their handlers have given them descriptive names. “Lucretia McEvil” tore up her tank nightly, chewing through plastic cable ties and digging up the water filter. “Leisure Suit Larry” was highly aggressive and would immediately begin groping with his tentacles anyone who opened his tank. “If he had been a person, he would have been cited for sexual harassment,” says Roland Anderson, a biologist at the aquarium.

To show in a quantitative way why this was so, Anderson and psychologist Jennifer Mather of the University of Lethbridge in Alberta, Canada, studied smaller, East Pacific red octopuses (*O. rubescens*). The scientists tested the octopuses’ responses to three of Anderson’s actions: opening their tank and looking at them,

Handlers of spotted hyenas in a captive colony consistently agreed on the animals’ personalities.



Hermann Brehm/naturepl.com



Reinhard/ARCO/naturepl.com

A study of European great tits found that aggressive individuals also tended to be bolder than their peers in exploring their environment.

those familiar with the animal to judge the extent of certain traits. “Humans are extraordinarily good at interpreting information in context,” Gosling says, so his approach can be more straightforward than trying to count behaviors, which sometimes fall into gray areas. But such an approach may not work as well for species like fish or water striders, which show less variety in their behavior than primates or dogs.

Evolution of Personality

With the data from these and other studies, scientists are beginning to understand why evolution has favored the persistence of different personalities. Evolution depends on variation, Gosling says, but in many ways, it selects out variation. There are no short-necked giraffes roaming the savannas anymore, he points out. “So the question is, why do we have differences in personality?”

On one level, personality is uniform among members of a species: “Stump-tailed macaques [*Macaca arctoides*] are easygoing. Bonnet macaques [*M. radiata*] are super affiliative. Pigtail macaques [*M. nemestrina*] can be very aggressive,” Capitanio says. This suggests that all individuals in a species may benefit from having a particular personality trait to a certain degree—which might be different from the degree that is beneficial to another species.

Nonetheless, there must be advantages to animals having different personalities at different times, because there is also individual variation within species. Renée Duckworth, an evolutionary ecologist at Harvard University in Cambridge, Massachusetts, is investigating this question in bluebirds. Duckworth has found that individual western bluebirds (*Sialia mexicana*) exhibit consistent

poking them gently with a bottle brush, and feeding them a crab. They found that individual octopuses’ responses were consistent from trial to trial, and their personality traits could be grouped by “activity,” “reactivity,” and “avoidance.”

Anderson’s and Gosling’s studies illustrate different disciplines’ approaches to understanding animal personality. Anderson’s comes from animal behavior research, in which scientists quantify specific behaviors such as how long it takes an animal to approach a new object or how often it strikes at an intruder. These behaviors are then tallied to make a quantitative assessment of personalities. Gosling’s originates in psychology studies: Ask



Zoos must take into account an orangutan's or other animal's personality when planning breeding efforts and deciding which animals are best suited for public view.

differences in aggressiveness, based on how often they attack, fly by, or hover near a model of a tree swallow (*Tachycineta bicolor*) introduced into their territory. These differences, she finds, are an asset in some situations and a liability in others.

The western bluebird lost habitat in Montana to logging and agriculture in the late 1930s, but is now returning to its original range thanks to nest-box introduction programs. These nest boxes are colonized more quickly by competing mountain bluebirds (*S. currucoides*), but the western bluebirds tend to win out in the end. Duckworth has found that among western bluebird males, aggressive individuals are more successful in booting mountain bluebirds out of nest boxes and colonizing new areas. However, these aggressive males invest less in caring for their young, leading to high mortality of their offspring. This puts them at a disadvantage compared with less aggressive males once colonization is complete, because less aggressive males raise more offspring.

Duckworth learned that over time, populations become less aggressive overall, because the situation in which aggression is favored has passed. She proposes that the nest boxes may ultimately change the overall distribution of western bluebird personalities by providing highly stable nest sites. The birds' traditional nest sites—cavities found in dead trees—are much more

ephemeral compared with nest boxes, requiring birds to seek new areas to colonize every few years. It makes sense, then, that evolution would have favored maintenance of both personalities in such an environment—where aggressiveness sometimes pays off and sometimes doesn't.

Still, it seems it would be better for individuals to be totally adaptable—to be bold when boldness is called for and timid when that offers an advantage—so why do consistent personalities that get animals in trouble persist? “I don't think we have a really good answer to that yet,” Duckworth says. “I think what we might find eventually is that there is some set of developmental constraints in how the hormone system or the nervous system is constructed—that somehow physiologically it can't be accomplished to change personality based on context.” Capitanio agrees that so far there is no answer, but his work with macaques suggests that different personalities are important in successful social groups. “Some of our evidence suggests that the groups that work best together are ones where some animals are high in sociability and some animals are low,” he says.

What Determines Personality?

It follows from what we know intuitively about human personality that past experiences—growing up in a particular culture or family situation—and inherited tendencies can affect one's personality. Not surprisingly, there is evidence in animals for a role of both nature and nurture in determining personality. Certain dog breeds are known for being high-strung or intelligent, indicating a genetic



requiring birds to seek new areas

Three-spined stickleback fish are among the surprising small creatures showing consistent personality traits.

component to their personalities, but a dog's training and history also make a difference. Researchers are working to put a finer point on the relative importance of both learned and heritable traits. A study by David Sinn at the University of Tasmania in Australia shows that in dumpling squid (*Euprymna tasmanica*), personality traits are passed from parent to offspring in varying degrees. Since squid do not care for their young, this family resemblance must be inherited, not learned from parents.

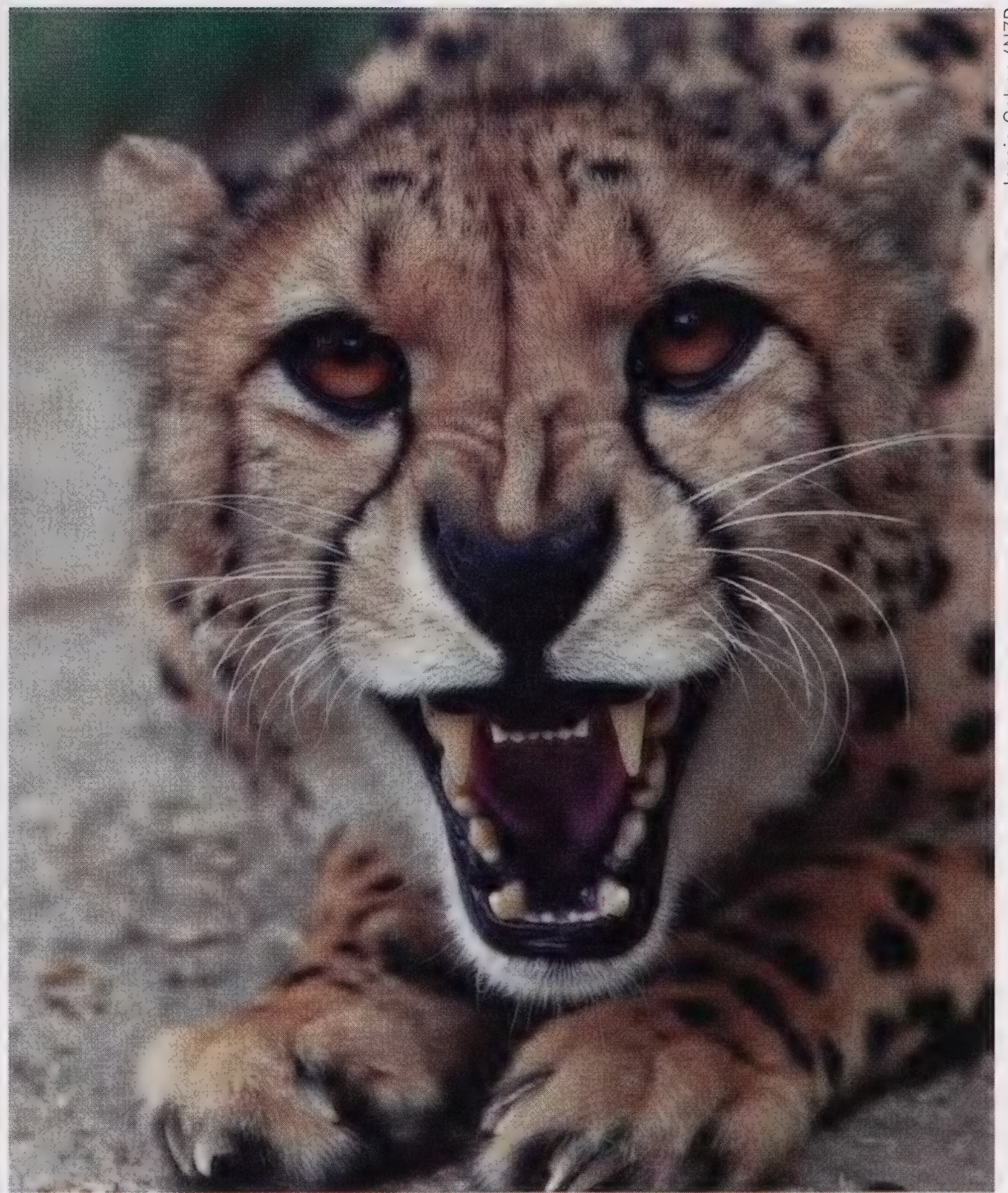
If personality can be inherited, then there must be genes responsible for personality traits. Scientists have recently found a candidate gene that may contribute to novelty-seeking or curiosity. Previous work had identified a gene in humans—DRD4—that appeared to be associated with novelty-seeking behavior, but the link was inconclusive, perhaps because it is confounded by environmental factors or because gene interactions in humans are especially complex. Animal experiments, on the other hand, allow researchers to control for these factors. So far, three groups of scientists have shown that variations in the DRD4 gene are associated with novelty-seeking in monkeys, great tits, and domestic horses, respectively. These findings suggest that the role of DRD4 in novelty-seeking predates the divergence of avian and mammalian lineages, according to Bart Kempenaers of the Max Planck Institute for Ornithology in Seewiesen, Germany, and colleagues, who reported the relationship between DRD4 and personality in great tits in the *Proceedings of the Royal Society B* last year.

But genes are not the whole story. Dingemanse recently showed that three-spined stickleback fish demonstrate personality only in certain environments. Stickleback exposed to predators in the wild show correlations among three traits—activity, exploratory behavior, and aggression—but this connection disappears among those living in ponds where no predators are present. Also, Duckworth examined the degree of aggression throughout the family tree of the western bluebirds in her study and found that neither genes nor environment alone explained the variance in personality she

Asian small-clawed otters (*Aonyx cinerea*) at the National Zoo. Recent research suggests that different personalities help make for a successful social group.



Megan Murphy/NZP



Jessie Cohen/NZP

Nasty cat? Putting knee-jerk impressions aside, scientists wouldn't judge personalities of cheetahs (*Acinonyx jubatus*) or other animals without lengthy investigations that assess behaviors.

observed. "There are definitely contributions from both," she says.

Although evidence indicates that animals have personalities, it is important to recognize that they do not have the same personality dimensions as humans. Anthropomorphism is still a concern, Gosling says. "One of the traits that people rate their dogs on is 'philosophical,'" he says. "I do not believe dogs are philosophical. We still have to be tremendously careful." Moreover, human personalities are much more complex than those of other animals. "Humans have all kinds of other things: values, goals, motives, identity," he says. There probably are also differences between the complexity of personality in nonhuman primates and, for example, stickleback fish, says Capitanio. "A lot of what is studied in fish or rodents or invertebrates is what's often characterized as 'shy-bold' continuums." By contrast, the macaques he works with have many personality dimensions. In other words, the extent of what it means for species to have personality may differ.

Putting Personality to Work

Personality research may only now be hitting its stride, but people have exploited heritable personality traits for centuries by selectively breeding domesticated animals. "You don't want your milk cows to be crazy wild animals, so you select for docility. You want your dogs to be friendly," Capitanio points out. A sheepdog should not be so aggressive that it hurts the sheep, nor so high-strung that it's afraid of herding larger animals, he adds.

Not surprisingly, Gosling found in comprehensively reviewing personality research in dogs that most published work on the subject has been done with working breeds, like German shepherds. Experts in various breeds know even more about personality traits in dogs than is published, he says, but the highly competitive nature of dog breeding means they keep much of it secret.

Now Gosling is putting his research on dog personality to use. He is working with animal shelters in the Austin, Texas, area to try to figure out how best to test dogs and potential adopters to ensure a good match. He is also trying to figure out which breeds of dogs are best for sniffing out bombs. You might think that these are the animals that have the best sense of smell, he says, but “the real factor is whether the dog freaks out at helicopters and whether it can continue to look for roadside bombs under those chaotic conditions.” It is their personality that matters.

Zoos also select for certain personalities. “In a zoo, if you’re looking at the effects of visitors on animals, you have to take into account that certain individuals are going to respond differently from others,” says Kathy Carlstead, a biologist at the Honolulu Zoo. For example, Anderson found that the Seattle Aquarium octopus named Emily Dickinson was too shy for exhibiting, so visitors could never see her. The aquarium eventually traded her for a more gregarious tenant.

Carlstead investigated A.T.A. Ritchie’s claim that rhinos had personality in the 1990s while working at the Smithsonian’s National Zoo. “Anybody will tell you that rhinos, even in the wild, have strong differences in personality,” she says. To test this, she asked keepers at 19 zoos to rate the personalities of their 60 rhinos based on elements of their behavior. She then tested most of the same rhinos’ personalities by presenting them with a new object (a traffic cone) and a new scent (the urine of an unfamiliar female rhino) and scored them according to six personality traits. She and her colleagues found that the keeper’s ratings matched the scored behaviors, and that most personality traits remained consistent when the rhinos were retested two years later.

Carlstead says understanding rhinos’ personalities can also help zoos figure

out how to get the animals to reproduce more successfully. “Any time you’re working with a small number of animals, individual differences are going to play a strong role.” So Carlstead also compared the extent of the observed traits with the breeding success of the rhinos in the study. For male rhinos, less sniffing and less dominance correlated with greater reproductive success. For females, better reproductive success was linked to less agitation or threat-associated behavior such as chasing or aimless, repetitive actions. The most successful match-ups for breeding were rhino pairs in which the female had a higher dominance rating than the male.

Denis Réale, an evolutionary ecologist at Université du Québec à Montréal, argues that such differences are important to consider when designing conservation efforts. Zoo breeding programs may select for bolder or shier animals or for those least stressed by living in zoos, creating selection pressures that could change the population over time, he says. “The problem is that these personality types may not be the ones that are most adaptive to the wild.”

Taken together, these findings suggest that personality is more than just a newly legitimate line of research, but an evolutionary force to be reckoned with. And it looks like the old expression is right: It takes all kinds. *Z*

—Jessica Marshall is a science writer in Saint Paul, Minnesota.



Octopuses’ responses to three actions convinced scientists that they could easily group the invertebrates by documenting consistent and quantifiable behavior.

This banded mongoose (*Mungos mungo*) may look “angry” or aggressive to a human but its body language may say something very different to another mongoose.



Escape!

No Picnic on Mount Kenya

Felice Benuzzi. 2005 Edition. (First published in 1953.) The Lyons Press, Guilford, Connecticut. 248 pp., softbound. \$14.95.

I was recently vacationing in Nepal, where I spent a few days in Pokhara, a lovely city that offers spectacular views of the soaring snow-clad mountains of the Himalaya's Annapurna Range. I have never, ever had any desire to climb mountains—I'm lazy and even standing still in the Mile High City leaves me breathless. But something about those 20,000-plus-foot peaks inspired a twinge of yearning. I fantasized about giving up my vices, getting in shape, and trekking over the 14,000-foot passes leading to Mustang, a high-altitude desert, photographs of which depict achingly beautiful wind-swept landscapes lightly dotted by red-hued temples and small, walled towns. Maybe I'd just stay there and become a mountain crazy lady. Mustang Susan.

I was reminded at that moment of the best book I've ever read about mountain climbing: a true story called *No Picnic on Mount Kenya*. (Actually, the only book I've ever read about mountain climbing but, because I like it so much, I figure it must be at least better than most.) On the face of it, author Felice Benuzzi's fantasy was even more unlikely to be fulfilled than mine.

An Italian colonial official stationed in East Africa during World War II, Benuzzi was interred in a British prisoner-of-war camp that happened to lie in view of Mount Kenya. Catching a starlit view of the glacier-capped summit one evening, he suddenly realizes what he needs to do to overcome the soul-destroying aimlessness of prison life: escape from the camp, climb Mount Kenya, and then return and accept the inevitable punishment of 28 days in a cell.

His life was now full of purpose, and he even manages to enlist two other POWs to join this quixotic escapade. Over the next

eight months, they buy, beg, borrow, barter, and scavenge to assemble a rough kit of essentials such as boots and blankets (as well as a small Italian flag to plant at the summit and a bottle of brandy in which, once emptied, they could leave a note). They fashion crampons of scrap metal and bits of barbed wire. And they plot their route with the aid of an illustration of Mount Kenya that adorns the label on a tin of meat and vegetable rations, that being their only map. Then, as prepared as they are ever going to be, the trio slip out of camp to tackle the 17,000-foot-high mountain. "So hungry for adventure and hazard were we, so convinced of our good luck that joyfully and happily we went on into the forest towards the lonely equatorial peaks, into a world untainted by man's misery and bright with promise."

Thus started an experience sometimes hilarious—Benuzzi has a flair for dry understatement—often harrowing, but ultimately triumphant. They succeeded in planting their flag on one of Mount Kenya's highest peaks, and 18 days after they left, they were back in camp, hobbled, hungry, and exhausted. "Thus, happily, we entered our cells. Life was truly sybaritic."

What is so memorable to me about Benuzzi's story is not the madcap mountaineering, however. Instead, it is his descriptions of their intoxicating encounters with nature. Indeed, the entire story is a testament to the power of the natural world to inspire the human spirit.

As they set out through the forest, the men are afraid of meeting elephants, rhinos, and leopards—and they do run into all three. But their first encounter with a lone bull elephant is filled with awe—"genuine, deep admiration"—not fear. After the elephant disappears into the dense foliage, Benuzzi reports, "For a long time we stood where we were, gazing spellbound at the closed curtain as if blinded by an unnatural vision. Had we not met at close quarters the king of the forests of Mount Kenya? Was he not worth the twenty-eight days' cells? He was worth everything, all our past and future toils."

In a forest full of majestic trees, vibrant flowers, colorful birds, and shining butterflies: "At every bend of the stream," Benuzzi writes, "new marvels made us either shout for joy like schoolboys on a holiday trip or

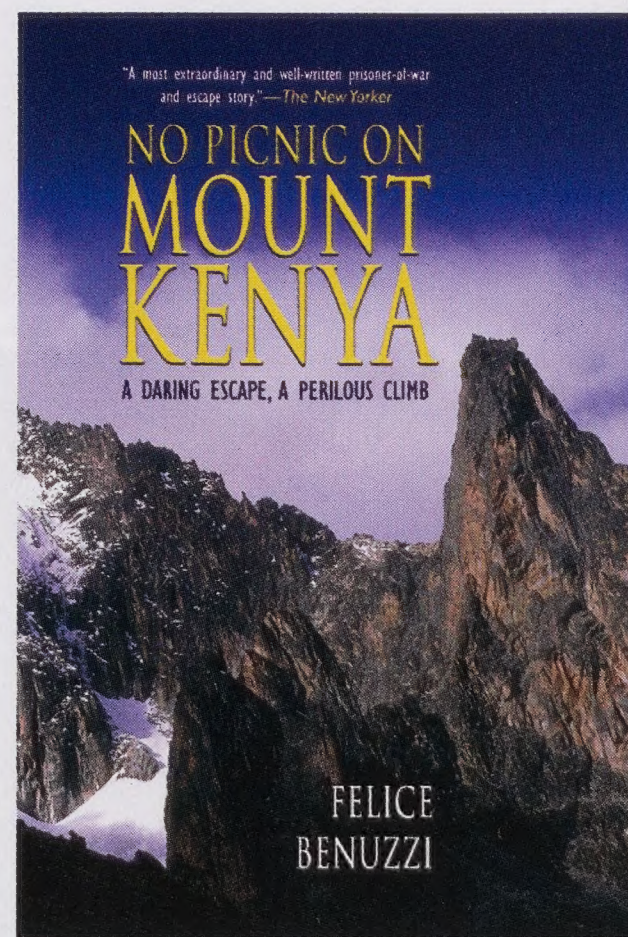
murmur confused words in a low voice, as though unwilling to violate such beauty by talking."

And of the peaks themselves, "...they had given us the memory of an inexhaustible store of beauty, on which we would draw during the years behind the barbed wire which would follow our adventure."

Benuzzi remained interred until the end

of the war and wrote *No Picnic* soon after. Subsequently, he served in Italy's diplomatic service, continued to climb mountains and write about his adventures, and while stationed in South America became a champion for the preservation of Antarctica. He died in 1988. *No Picnic* was his only work written in English; I feel lucky that he made this exception. It is a marvelous story. And perfect for anyone contemplating escape.

—Susan Lumpkin



No Place Like Home



When they leave their birthplace to find their first home, brush mice (*Peromyscus boylii*) seem to remember that mother knows best. A scientist from the University of California, Davis, radio-collared 18 brush mice on the cusp of sexual maturity at Quail Ridge Reserve in northern California. The mice were born in two different habitat types that occur in

close proximity—woodland, which is dominated by trees, and chaparral, dominated by a shrub. Although 90 percent of the young mice ventured into the habitat that was different from their mothers' before settling down, 89 percent of them decided to live in their natal habitat type. The study, which was published in December in the *Proceedings of the Royal Society B*, indicates that dispersing mammals choose their adult homes based on their past experiences, and that even within the same species, individual animals may have different habitat preferences.

What's in a Name?

Domestic guinea pigs (*Cavia porcellus*) are such familiar pets in the U.S. that they hardly seem mysterious. But their common name, which dates to at least 1664, is a conundrum. Guinea pigs are native to South America, not



South American region called Guiana, where some wild caviies live. Or, Europeans first introduced to caviies by guineamen—slave traders who acquired human cargo in the Guinea region of Africa and caviies for meat

New Guinea or Africa. And they are not pigs, but caviies—small, tailless rodents that belong to the same family as rock caviies (*Kerodon rupestris*) and capybaras (*Hydrochaeris hydrochaeris*). "Guinea" may be a corruption of the

in South America—may have been confused about the furry creatures' origins. The porcine portion of the moniker may refer to guinea pigs' stout build, small ears, and their tendency to squeak or squeal when excited.

An ocean quahog (*Arctica islandica*) claimed the title of the oldest known animal in 2007. Scientists who found the clam near Iceland say it was at least 405 years old when it died.

Do Turtles Shed Their Shells?



An invertebrate may need to shed its hard exoskeleton several times to accommodate its growing body, but a turtle has a single shell throughout its life. This shell's outer layer is made of keratin, the same protein that's in our fingernails, or cartilage. Beneath that is a calcified layer of living cells that contains blood vessels and nerves and is fused to the turtle's vertebrae and ribs. As the turtle grows, its shell grows with it, just like the bones inside its body.

In Season



The year's first warm rains jump-start the libidos of spotted salamanders (*Ambystoma maculatum*). These black-and-yellow am-


phibians, which may be nearly eight inches long as adults, leave their underground burrows in early spring to find mates in ponds, streams, and woodland pools. Females lay as many as 200 eggs in jelly-like masses and the young begin to hatch in late April.

Fact or Fiction: All Male Lions Have Manes

Almost all male African lions (*Panthera leo*) have manes that emerge in adolescence and grow longer as they mature. Lions are the only cats with this regal adornment, and its purpose is unknown. It may protect a male's neck during fights for dominance, intimidate rivals, or attract females. But a mane is also costly. It takes energy to grow and maintain, harbors parasites, and impedes heat exchange. One study shows that lions in warmer, drier climates grow smaller manes than those in cooler, humid climates. Perhaps that's why a small population of adult males in Kenya's hot and arid Tsavo East National Park are maneless.



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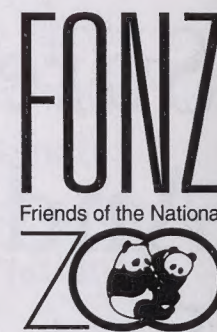
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